

Wireless sensors for pregnant women could revolutionize medical monitoring

By Miles Martin

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Researchers have developed a series of small, wireless sensors that can monitor the vital signs of pregnant women and their babies, replacing the bulky, antiquated systems that have been used for fetal monitoring for decades.

In a study published May 10 in *PNAS*, the interdisciplinary team tested the device on 576 women from both low- and high-resource areas, finding that it was able to monitor all of the same information as older systems. This includes blood oxygen levels, temperature, heart rate and blood pressure. The system can also pick up information about the mother's physical movements and laboring positions, which older systems cannot do.

Each year, 295,000 women die during childbirth, 94% of whom come from low- and middle-income countries. More efficient and accessible fetal monitoring could reduce these figures, the researchers argue.

"What we've done represents the world's first comprehensive monitoring platform that really gives all

the vital signs that you need to monitor both women and their fetuses in a noninvasive, continuous, wearable way that works with your smartphone," senior author Shuai Xu said in an interview with *Fastinform*. Xu is a professor of dermatology at Northwestern University.

Fetal monitoring systems can be the first line of defense for detecting abnormalities such as congenital [heart defects](#). They are also essential for ensuring the health of mother and baby during labor and delivery. But many women will only see a fetal monitoring device at a doctor's office or hospital. This is because current systems involve an unwieldy series of wired electrodes and belts that are linked to bulky machines, effectively tethering the mother to a bed.

[The Academic Times](#)
"Being able to move, breathe and feel comfortable during labor is so important," said study co-author Jessica Walter, an obstetrician and gynecologist at Northwestern Medicine. "Mothers often don't want to move because the monitoring bands can slip out of place, and they don't want the bands to have to be readjusted."

Walter herself was pregnant with twins throughout the study, which provided a great opportunity for her to test the technology.

"It's incredibly freeing to have a small sticker on your chest and belly," Walter said. "I completely forgot about them. Yet they collected the same information as a hospital — all while I was naturally moving around."

The new system uses three sensors. One goes on the abdomen to detect the baby's heartbeat and the mother's contractions. Another goes on the chest to monitor the mother's body temperature and heart rate. A third goes around the finger to monitor blood oxygen and peripheral temperature.

Each of these sensors adheres directly to the mother's skin and is completely wireless, powered instead by a rechargeable lithium-ion battery. The gathered data is transmitted via Bluetooth to the mother's smartphone or to a nurse's display station.

"Instead of having to go to your doctor [and] strap on all kinds of gizmos and gadgets to your body to a point where you can't even go to the bathroom, imagine wearing essentially what amounts to three soft, flexible bandages that you just sort of stick on, and activate with your phone," Xu said.

For the study, the team tested its device on 576 women distributed between Chicago and Lusaka, Zambia. The reason for such geographic diversity in the study areas is that the researchers wanted to account for differing access to health care resources. Lower-income countries frequently have little access to any pregnancy monitoring, and it is difficult to bring conventional systems to these locations on account of the systems' weight and power usage.

After confirming that their devices could work even in areas with fewer resources, the researchers partnered with

the Bill & Melinda Gates Foundation to deploy the device around the world, starting with hospitals in Zambia, Ghana and India.

"Childbirth can be a dangerous and traumatic event, even in the best of circumstances where parents have access to the most advanced systems available in health care," said co-senior author John A. Rodgers, director of the Querrey Simpson Institute for Bioelectronics at Northwestern University. "Inadequate equipment and insufficient health care personnel can create significant challenges. Our technologies have powerful potential in these contexts."

Rogers also led the device development at Sibel Health, an offshoot company of Northwestern that is now commercializing the monitors. The researchers hope that commercial availability of such a noninvasive system will make pregnancy monitoring a more routine procedure throughout all pregnancies.

"I think this monitoring can be universal, whether you're having a really healthy pregnancy versus one that [is] high-risk," Xu said.

With this device in the books as a success, the team is continuing to expand the scope of what its technology can do, collaborating with the U.S. Department of Defense to develop new COVID-19 monitoring systems. The team also won [an award](#) from *Nature* last year for applying the technology to monitoring newborns.

"At the end of the day, I think we're trying to revolutionize medical monitoring across the board," Xu said.

The study, "Comprehensive pregnancy monitoring with a network of wireless, soft, and flexible sensors in high- and low-resource health settings," published May 10 in PNAS, was authored by Dennis Ryu, Dong Hyun Kim, Jong Yoon Lee, Ha Uk Chung, Jingyue Cao, Elena Kulikova, Hajar Abu-Zayed, Rachel Lee, Marc Hill, JooHee Lee, Edward Kim, Yerim Park and John A. Rogers, Sibel Inc.; Joan T. Price and Jeffrey S. A. Stringer, University of North Carolina at Chapel Hill; Emily Allen, Jessica R. Walter, Hyoyoung Jeong, Knute L. Martell, Michael Zhang, Brianna R. Kampmeier, Hokyung Jang, Hany Arafa, Claire Liu, Amy S. Paller, Ashish Premkumar, William A. Grobman and Shuai Xu, Northwestern University; Maureen Chisembele and Bellington Vwalika; University of Zambia; and Ntazana Sindano and M. Bridget Spelke, University of North Carolina Global Projects-Zambia.